The Arctic Marine Pulses Model

Linking Contiguous Domains in the Pacific Arctic Region

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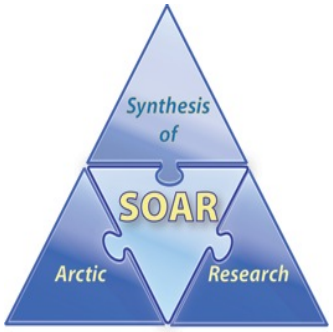
OUTLINE

BOEM
Bureau of Ocean Energy Management



- FOUR PAN-ARCTIC CONTIGUOUS DOMAINS
- BUILDING THE ARCTIC MARINE PULSES (AMP) MODEL
- SEASONAL BIOPHYSICAL PULSES IN THE PACIFIC ARCTIC
- THE AMP MODEL: A STEP TOWARDS HUMAN-INCLUSIVE ECOSYSTEM ASSESSMENTS?
- NEXT STEPS

Overarching Goal : *linking the concept of contiguous domains to existing pelagic-benthic coupling and advective models to provide an integrative approach to ecosystem assessment*

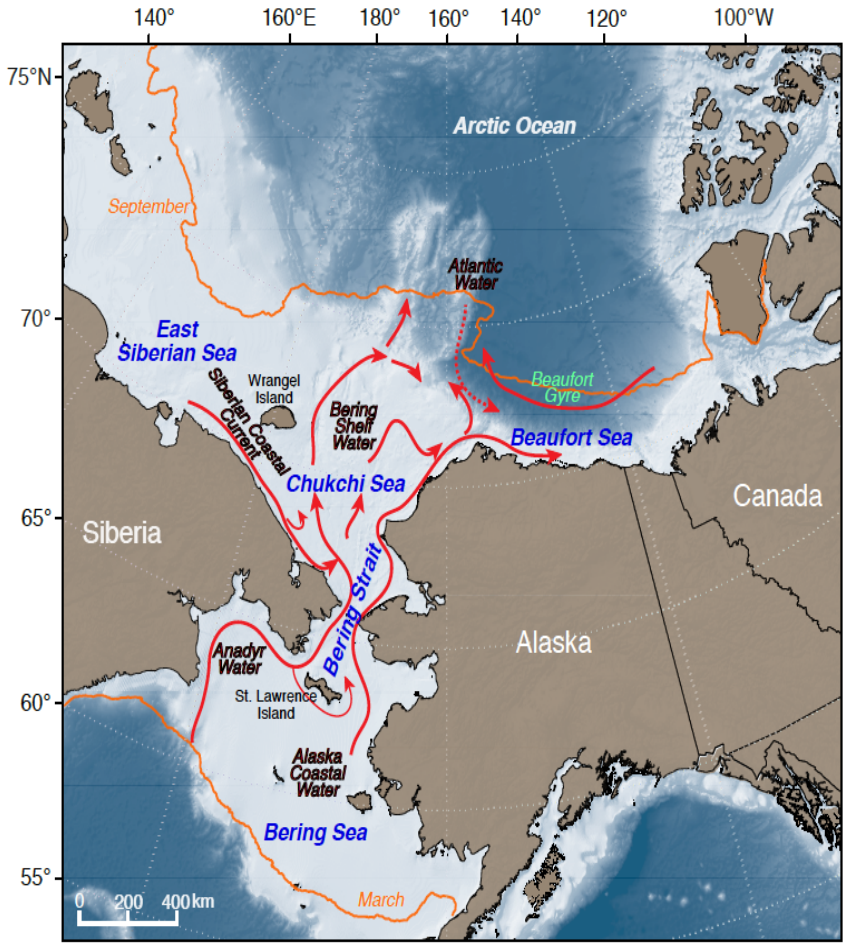
Moore and Stabeno (2015)

PAN-ARCTIC CONTIGUOUS DOMAINS

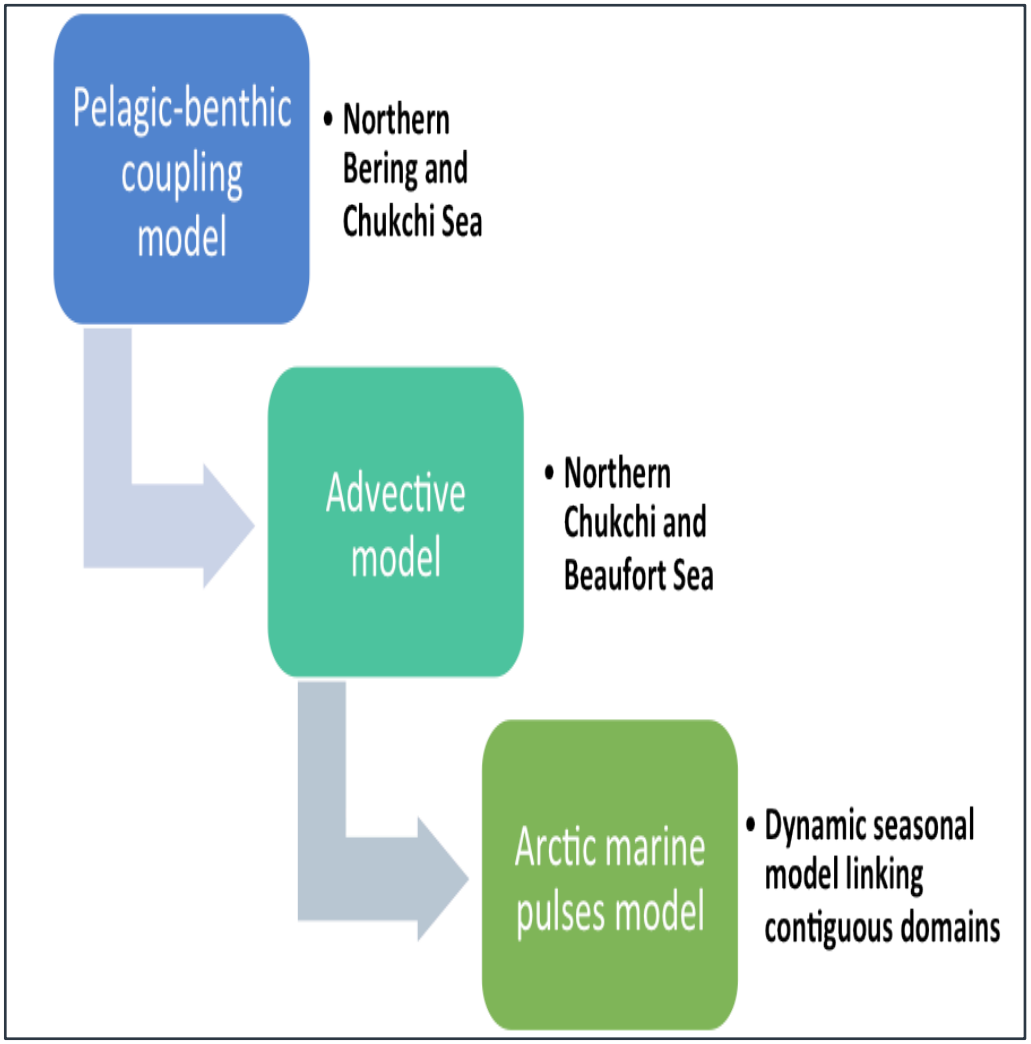
Carmack and Wassman (2006)

FOUR DOMAINS: associated processes

- **Pacific Arctic** (focal domain): strong seasonal and inter-annual variability of in flow @ Bering Strait
- **Seasonal Ice Zone**: phytoplankton blooms & ice algal deposition, which links pelagic-benthic coupling model to the AMP
- **Pacific Margin/Slope**: along-slope transport, upwelling & eddy formation, which links advective model to the AMP
- **Riverine and Coastal**: heat & fresh water input Yukon, Colville, Sag and Mackenzie outflows in the focal domain

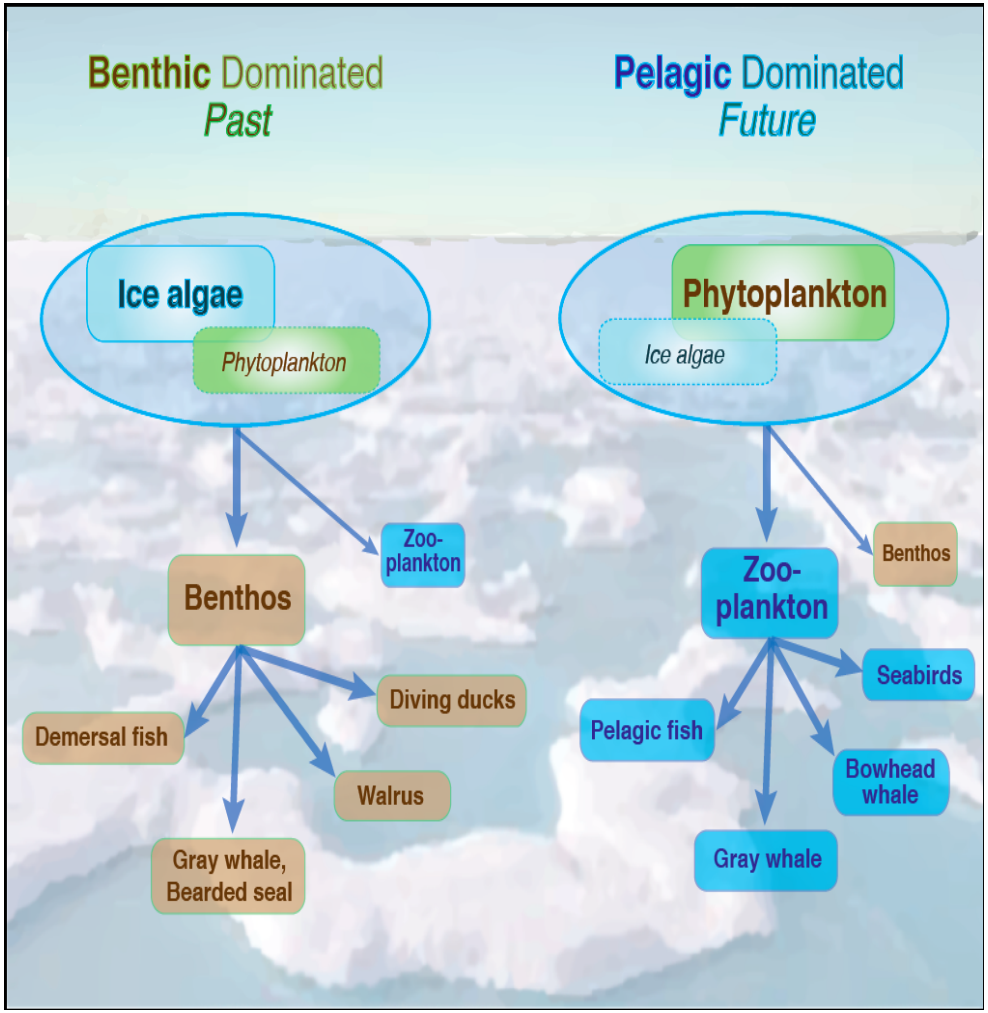


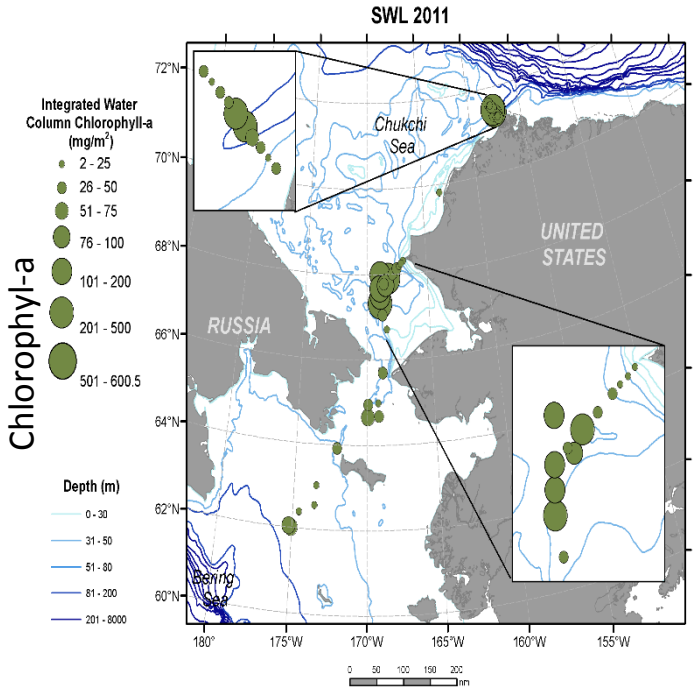
Building the AMP Model

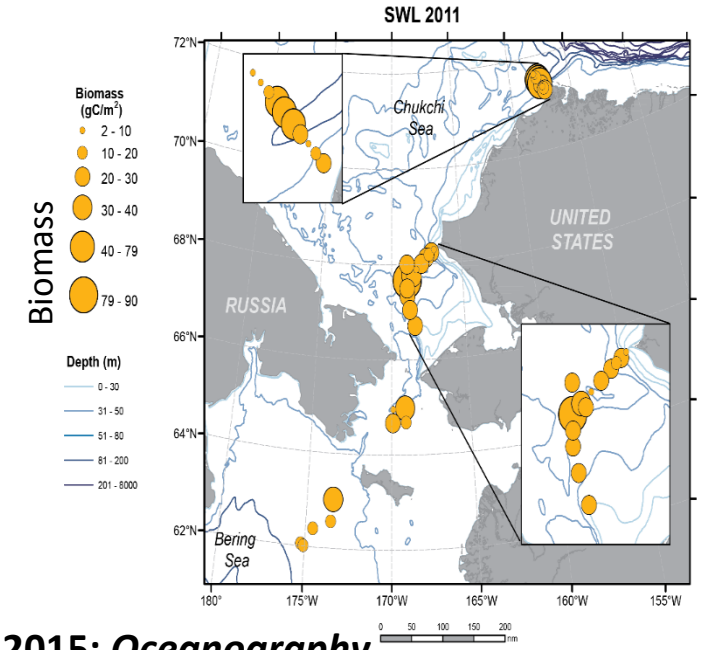


- Ice retreat triggers phytoplankton production and deposition of ice algae to shelf-benthos
- Ice retreat corresponds with Bering Strait inflow, with late-summer retreat into basin fostering wind-driven upwelling and eddy formation along slope
- Rivers pulse fresh-warm water into coastal systems, influencing local production and prey aggregation

PELAGIC-BENTHIC COUPLING MODEL



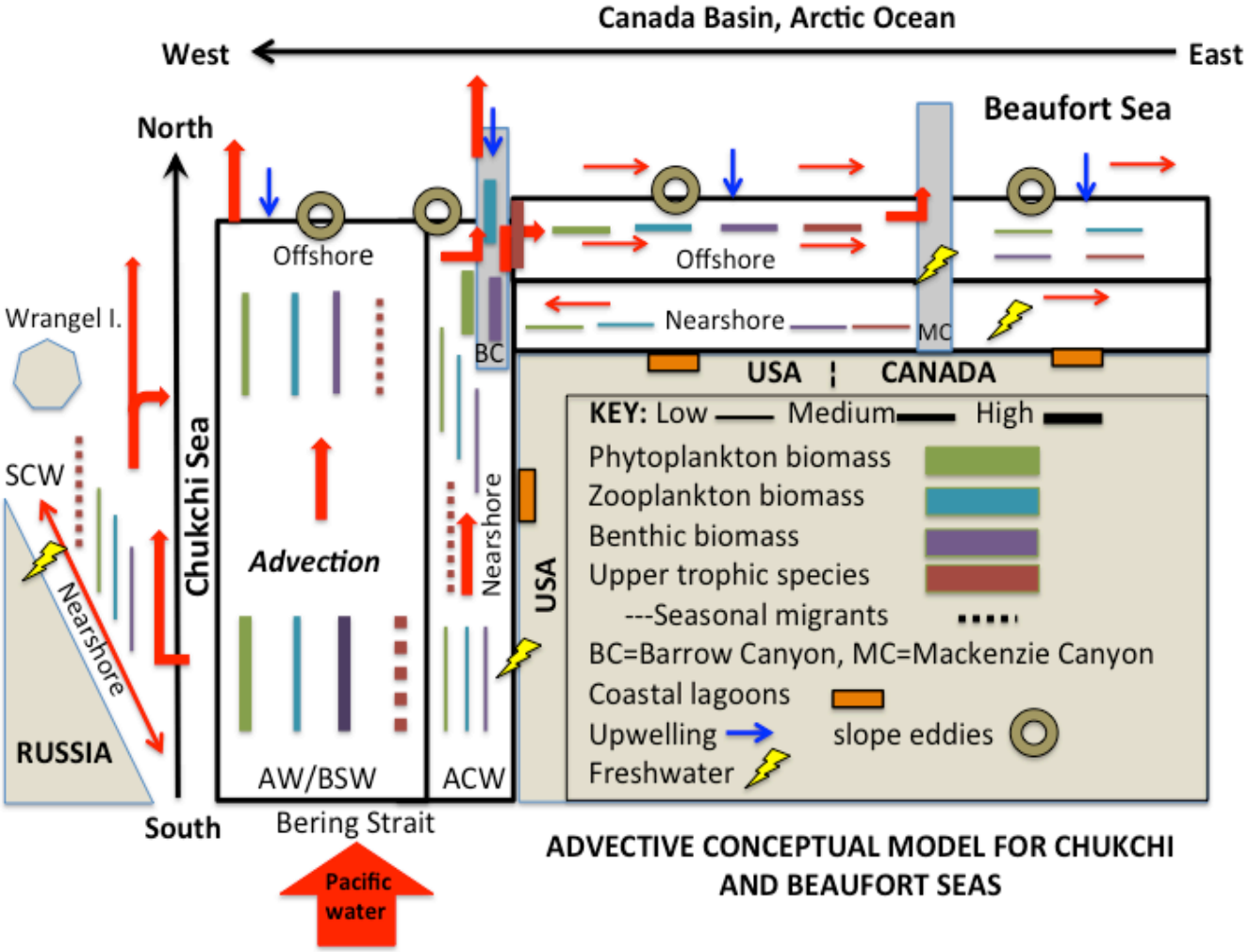




Grebmeier et al. 2015: *Oceanography*

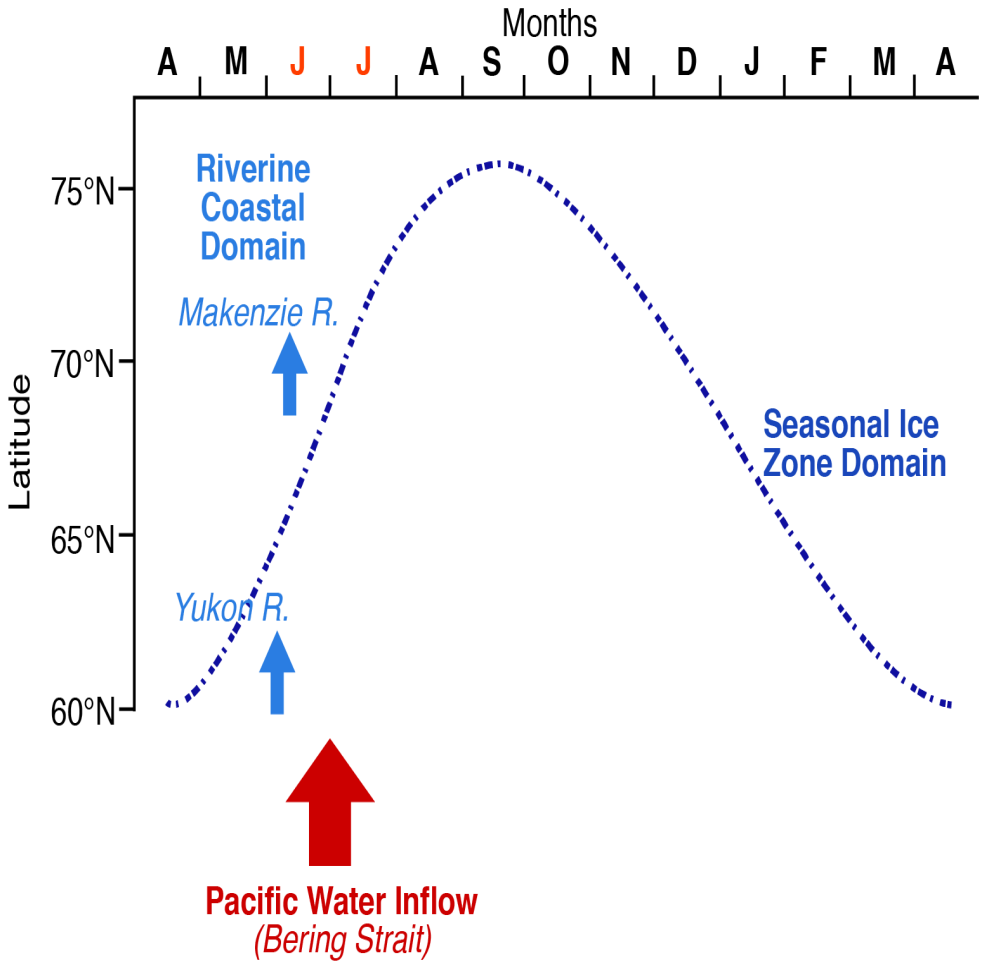
ADVECTIVE MODEL

Grebmeier et al. 2015. PacMARS Final Report



THE ARCTIC MARINE PULSES (AMP) MODEL

a seasonal 'construct' linking contiguous domains in the Pacific Arctic



Seasonal Biophysical Pulses
Pacific Water Inflow

- Peak inflow through Bering Strait in June-July; 50% increase, 2001-2013 (Woodgate et al. 2015)

Initiates Advective & AMP model

- Atmospheric drivers?

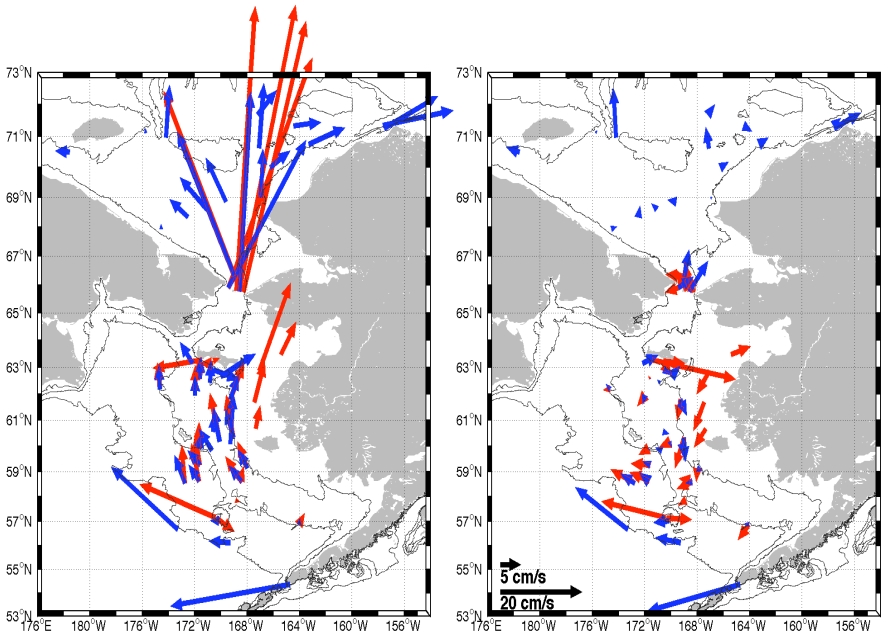
A = Aleutian Low/west & Beaufort High/ enhanced

B = Aleutian Low/east & Siberian High/ enhanced

Moored current meter measurements, October-April (1979-2010);

red = 10-20m; blue = 30-60m

Danielson et al. (2014)



A **B**

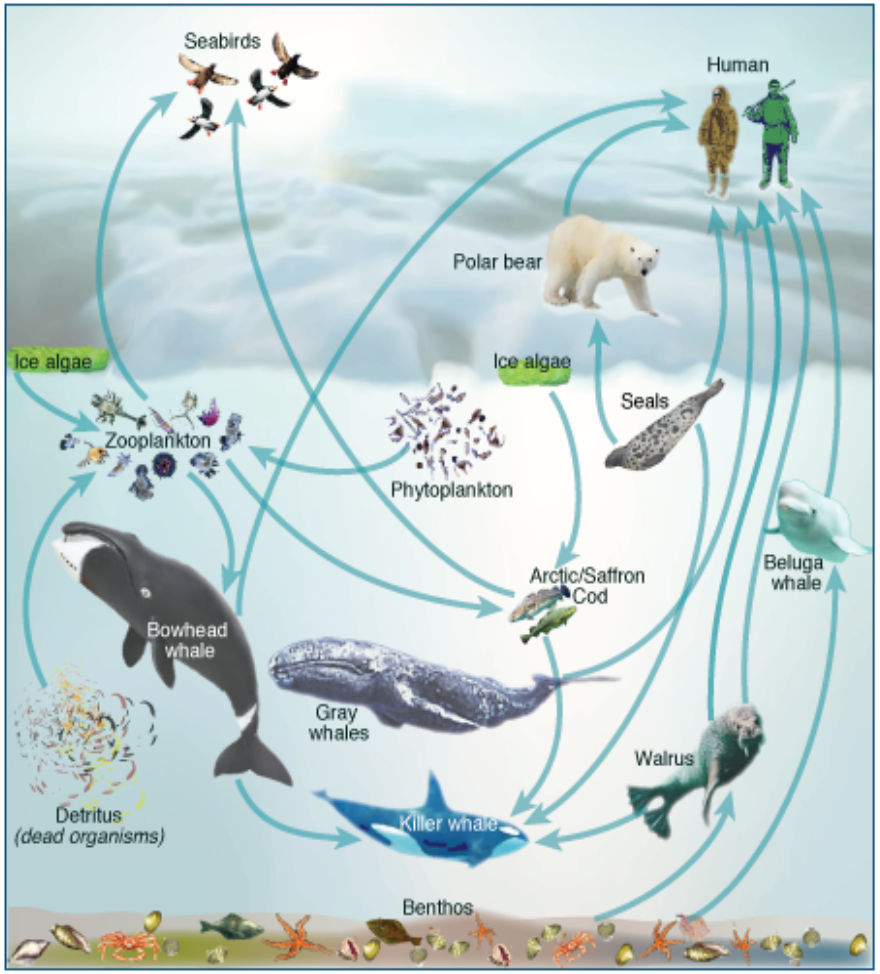
Seasonal Biophysical 'Pulses' - a few examples -

- Spring – regional phytoplankton-bloom pulses (Mordy presentation; **Arrigo et al. 2015; Ardyna et al. 2014**) + riverine discharge pulses (**Wood et al. 2015**)
- Summer – fresh-warm inflow-pulse @ Bering Strait (**Woodgate et al. 2015**), and offshore Icy Cape (**Stabeno et al.**)
- Late Spring & Summer – latitude dependent, pelagic-benthic coupling pulses on shelves (**Grebmeier et al. 2015**)
- Late Summer, Fall & Winter – advection, upwelling & eddy pulses along slope (Ashjian presentation; **Okkonen et al. 2014; Pickart et al. 2013; Llinás et al. 2009**) and 'polynya pulses' from Barrow Canyon up-canyon flow (**Ladd et al.**)
- Late Fall & Winter – rapid-cooling 'pulse' coincident with sea ice formation (**Stabeno et al.)**

THE AMP MODEL

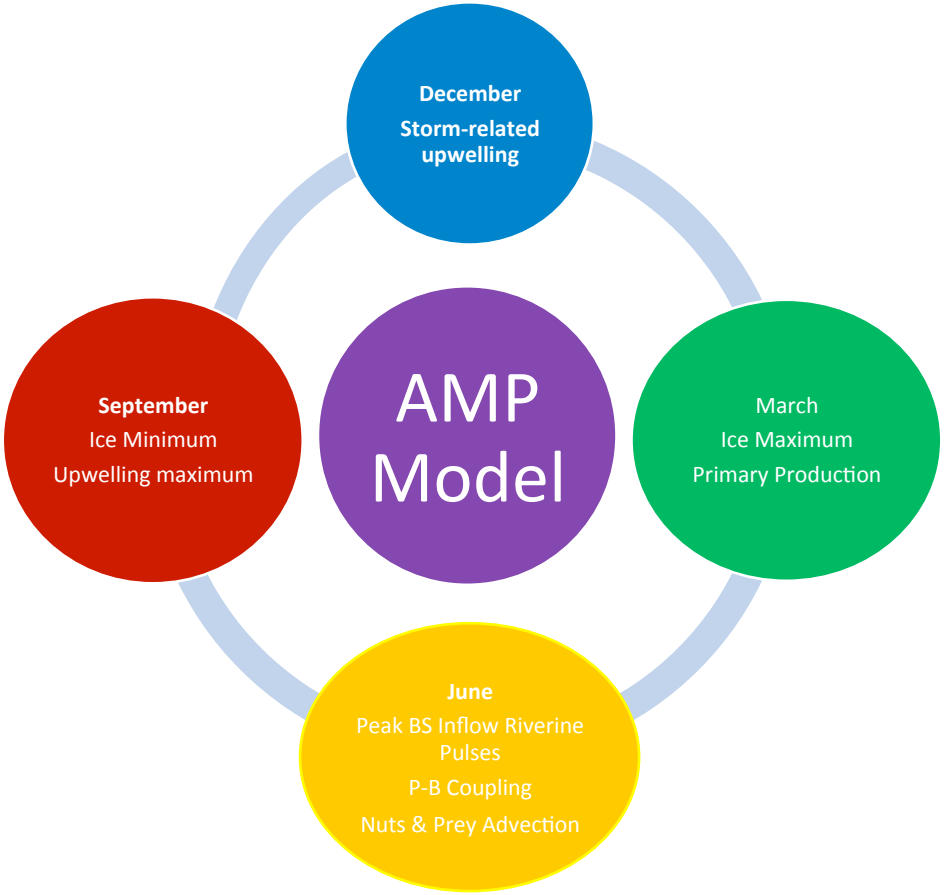
a Step Towards Human-Inclusive Ecosystem Assessments?

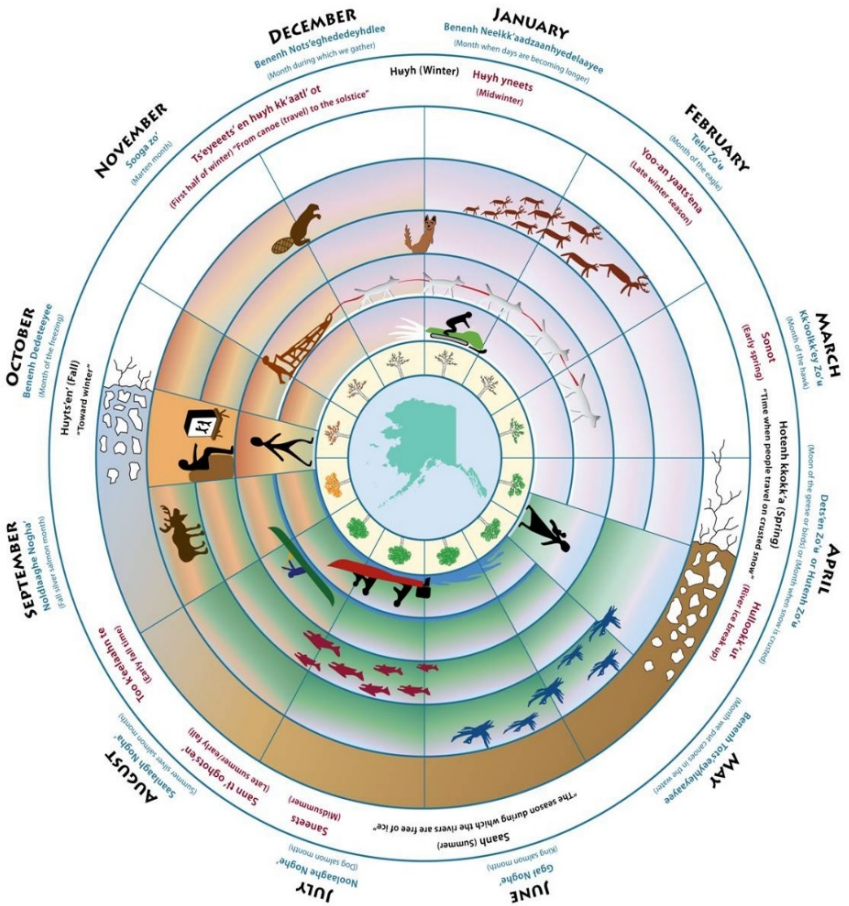
- Humans are at the apex of Arctic food webs and rely on marine resources for food and culture
- The AMP Model emphasizes temporal events (pulses), which can link biophysical processes with human subsistence activities
- Goal = holistic assessment of ecosystem processes and state



Conventional Science & Local Observations/Partnerships

Finding Complementary Sampling Scales





Research ‘Partnerships’: The Bowhead Example

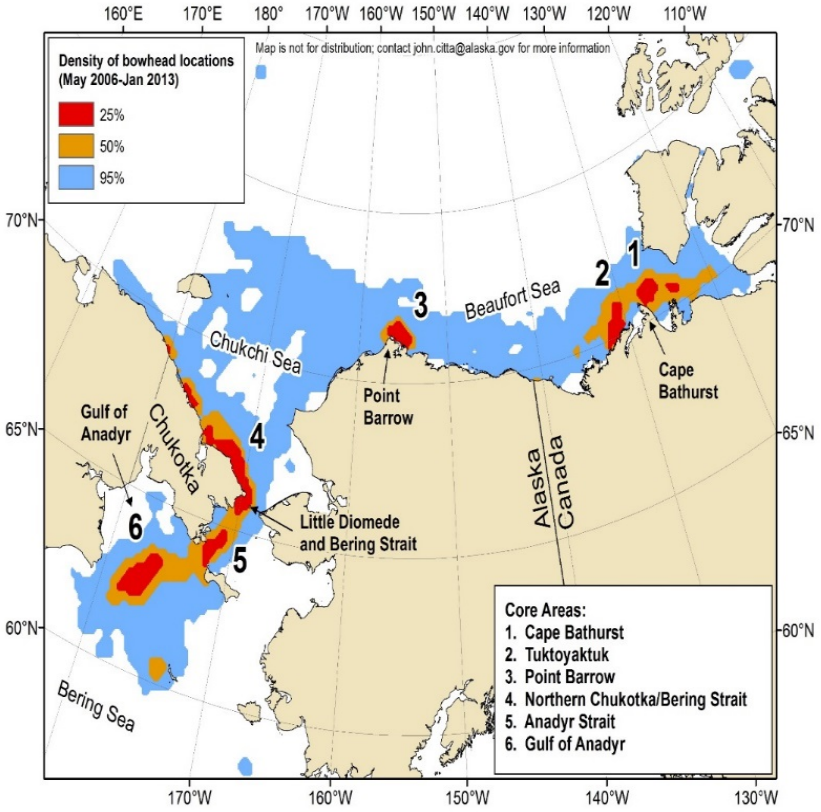
Local Ecosystem Observers & Samplers

photo by Sue Moore

Bowhead whaling = nutritional & cultural ‘keystone’

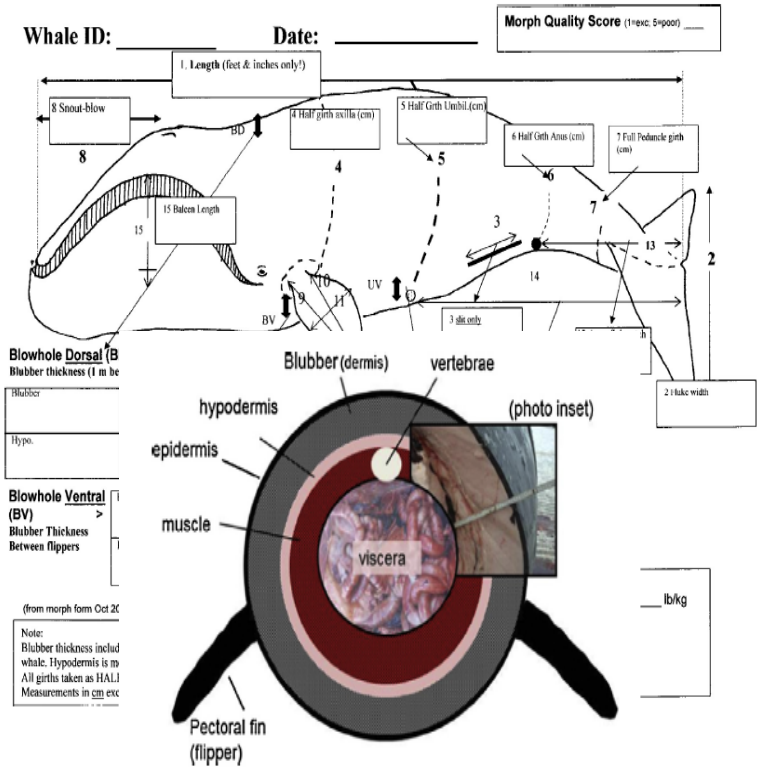
Resulting in 'Conventional Science' papers on Bowhead Whale Habitat Use and Body Condition *based upon* Partnerships with Local Hunters: 2 examples

- Core-Use Areas



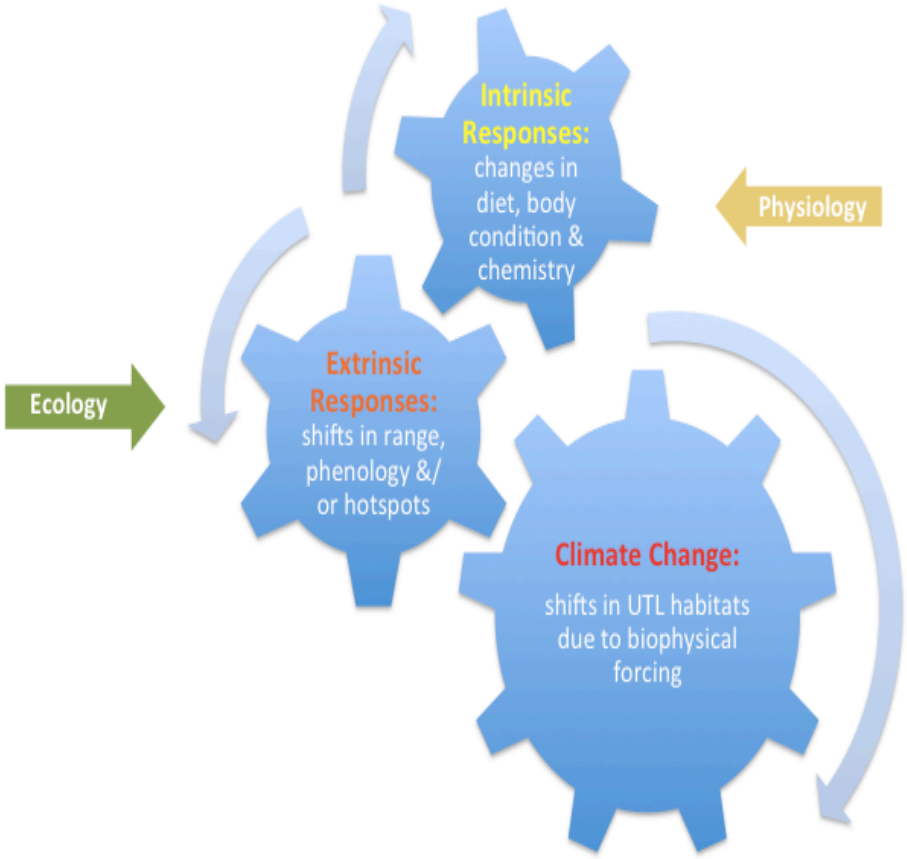
Citta et al. 2015

- Body Condition



George et al. 2015

Upper Trophic Level Species as Sentinels of Ecosystem Variability and Link To Humans



- Marine fishes, birds and mammals reflect ecosystem variability by changes in distribution, abundance and body chemistry
- These shifts are responses to changes in the integrated ecosystem
- Humans in the Arctic rely on UTL species for subsistence
- Humans outside the Arctic identify with UTL species as ecosystem icons

THE AMP Model: Next Steps

- Expand on the temporal focus of the AMP model – how has/is the phenology of the Pacific Arctic marine ecosystem changed? & what future scenarios are possible?
- Develop visualization products of Arctic Marine Pulses for the Pacific Arctic region
- Investigate the utility of AMP Model for other Arctic regions

http://www.arctic.noaa.gov/soar/

With THANKS to:

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NPRB for invitation to speak

YOU for your attention